

TITLE OF THE INVENTION

LITHIUM POLYMER BATTERY AND METHOD FOR PRODUCING THE
SAME

BACKGROUND OF THE INVENTION

The present invention relates to a lithium polymer battery in which a gel electrolyte comprising a liquid organic electrolyte and a host polymer retaining thereof is interposed between the positive electrode and the negative electrode as a separator.

Lithium ion secondary batteries, which include a liquid organic electrolyte, a lithium-containing complex oxide as a positive electrode active material and a carbon material as a negative electrode active material, have a high voltage and high energy density, and exhibit excellent characteristics at low temperatures as compared with secondary batteries having an aqueous electrolyte. These batteries are also excellent in the cycle stability and safety since they do not use a lithium metal in the negative electrode, and they have rapidly been put into practical use. Also, lithium polymer batteries using, as a separator, a gel electrolyte comprising a liquid organic electrolyte and a host polymer retaining thereof have been researched as thin and lightweight novel batteries.

Since the separator of lithium ion batteries are composed of materials which do not readily dissolve or swell

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in a liquid organic electrolyte, the cycle characteristic of the batteries rarely deteriorate due to the reaction of the separator with the electrolyte. Also, binders contained in the positive electrode and the negative electrode of lithium ion batteries do not relate to the deterioration in the cycle characteristics.

However, since lithium polymer batteries use a gel electrolyte as the separator, chemical stability and reactivity with a liquid organic electrolyte of a host polymer greatly influence the deterioration of the batteries particularly at high temperatures. For example, a liquid organic electrolyte using lithium hexafluorophosphate as a solute reacts with a host polymer such as polyethylene oxide at high temperatures and cuts a network structure formed by the host polymer. As a result, the electrolyte becomes unable to stay in the gel state and the function of bonding the positive electrode and the negative electrode is impaired.

As the host polymer of the gel electrolyte, a variety of polymer materials have been proposed so far. Polymer materials containing an ethylene oxide unit (e.g. Japanese Laid-Open Patent Publication No. Hei 3-171567) have excellent affinity with liquid organic electrolytes, but they have problems concerning thermal stability because they cause sol/gel transition at high temperatures and are easily oxidized.

Materials composed of polyacrylonitrile (e.g. Japanese

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Laid-Open Patent Publication No. Hei 4-306560) show incombustibility and give a high ion conductivity. However, they have a good affinity with a limited number of liquid organic electrolytes and have problems in the thermal stability of the gel.

Polymer materials containing a vinylidene fluoride unit (e.g. U.S. Patent No. 5,296,318) have a wide potential range where they are electrochemically stable and have incombustibility because they contain fluorine. However, they have the problem that they have a low affinity with liquid organic electrolytes at high temperatures.

Materials composed of polyacrylate (e.g. Japanese Laid-Open Patent Publication No. Sho 55-35420) are excellent in retention of liquid organic electrolytes, but they are electrochemically unstable.

Also, there are proposed methods of copolymerizing each of the above materials with other monomers, chemically crosslinking the same, or alloying the same with other polymers.

For example, proposed are a mixture of alkylene oxide with a fluorocarbon polymer (Japanese Laid-Open Patent Publication No. Hei 11-35765), and a mixture of polyvinylidene fluoride with a copolymer containing an acrylate unit capable of bonding with metals and an organic compound having a mercapto group (Japanese Laid-Open Patent Publication No. Hei 11-228902). However, there is the problem that a gel

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